(19) RU (11) 2140537 (13) C1

(51) 6 E 21 B 47/022, 7/04



РОССИЙСКОЕ АГЕНТСТВО ПО ПАТЕНТАМ И ТОВАРНЫМ ЗНАКАМ

# (12) ОПИСАНИЕ ИЗОБРЕТЕНИЯ

## к патенту Российской Федерации



(21) 97121250/03 (22) 18.12.97

(24) 18.12.97

(46) 27.10.99 Бюл. № 30

(72) Васарыгин Ю.М., Будников В.Ф., Гераськин В.Г., Коновалов С.Ф., Макаренко П.П., Стрельцов В.М., Сугак В.М., Черненко А.М., Польников А.В.

(71) (73) Предприятие "Кубаньгазпром"

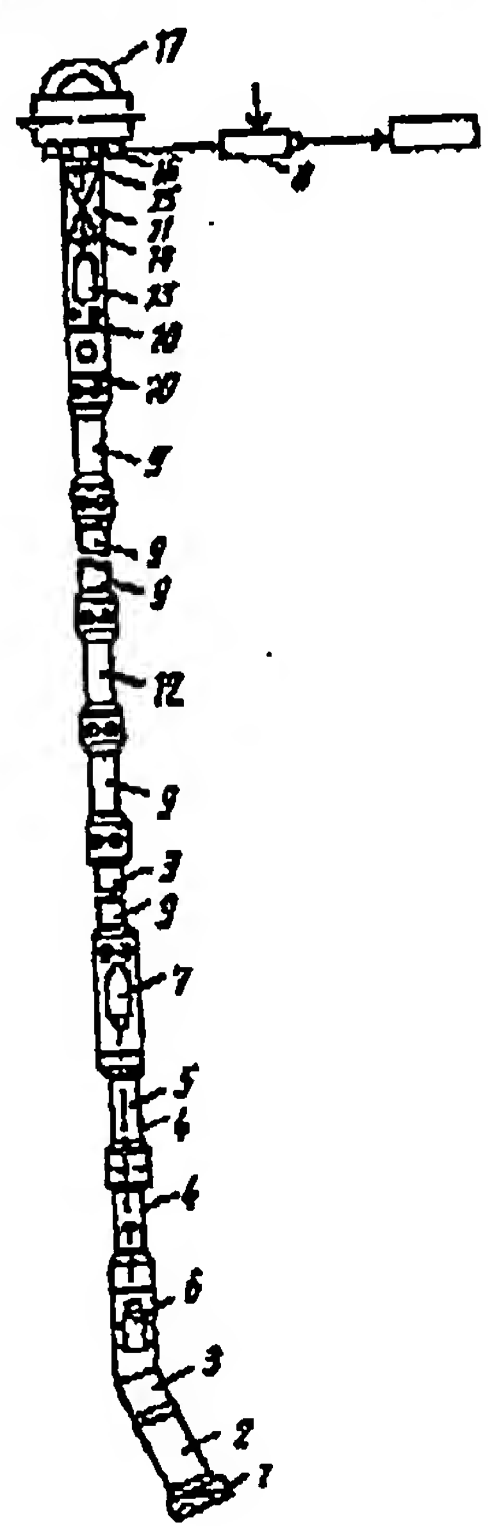
(56) RU 2078921 C1, 10.05.97. SU 141555 A, 02.11.61. SU 259773 A, 04.05.70. SU 471427 A, 01.09.75. SU 1141187 A, 23.02.85. SU 1640384 A1, 07.04.91. SU 1490268 A1, 30.06.89. RU 2040691 C1, 27.07.95. RU 2055178 C1, 27.02.96. US 4806928 A, 21.02.89. US 5042597 A, 27.08.96. US 5341886 A, 30.08.94. DE 3912614 A1, 02.11.89. DE 3428931 A1, 05.06.85.



(98) 350063, Краснодар, ул.Мира, 34, НТЦПП "Кубаньгазпром"

(54) СПОСОБ БУРЕНИЯ НАКЛОННЫХ И ГОРИЗОНТАЛЬНЫХ СКВАЖИН

(57) Изобретение относится к технике проходки и измерения текущих координат забоя наклонных и горизонтальных скважин



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The closest method in terms of technical features and results available consists of drilling oblique and horizontal boreholes while drilling vertical borehole shafts, installing a face engine and an oblique transfer device in the drilling apparatus at the point of curvature, inserting an inclinometer into the pipes using geophysical cable and fixing it in the lower part of the drilling apparatus, drilling the oblique and horizontal parts of the borehole by regular rotary drilling, drilling using a face engine, and monitoring the borehole face co-ordinates according to the data from the inclinometer (2).

The disadvantages of the prior art are as follows:

- the need to draw the geophysical cable behind the pipe through the cable conductor at the point of curvature creates a danger of the cable crumpling or breaking;
- the presence of the cable behind the pipe does not allow rotary drilling;
- the presence of the cable behind the pipe does not allow reliable sealing of the borehole using preventors when accidental ejection of gas or oil occurs.

The aim of the proposed invention is to improve the reliability of drilling.

The established aim is achieved because according to the invention, when using the prior method of drilling oblique and horizontal boreholes by drilling the vertical borehole shaft, installing a face engine, an oblique transfer device and alighting gear in the drilling apparatus at the point of curvature, inserting the inclinometer into the pipes in the apparatus using geophysical cable and fixing it in the alighting gear, drilling the oblique and horizontal parts of the borehole and monitoring the regular co-ordinates of the borehole face by data from the inclinometer, the lower pipe transfer device with the electronic assembly inside is mounted in the apparatus after the inclinometer is inserted and fixed into the alighting gear, allowing signals to be received and transmitted. In this way the lower lead-in of the assembly is connected to the upper joint of the cable coming from the inclinometer, and the upper lead-in is connected to the wireless data transmission system, in which drilling pipes and a balloon-screen with electrical coils (placed in the nipples and couplings of the locks and linked to each other by wire attached to the body of the pipes and the balloon-screen) are used. Above the balloon-screen installed in the drilling gear, the upper pipe transfer device with the electronic assembly positioned inside is mounted, thus allowing signals to be received and transmitted. In this case its lower lead-in is connected to the wireless data transmission system and the upper lead-in to the cable passing inside the square positioned in the drilling apparatus above the upper pipe transfer device, above which an exit pipe transfer device with an electronic assembly is installed, thus allowing signals to be received and transmitted. The lower lead-in of the assembly is thus connected to the upper joint of the cable passing within the square, and the upper lead-in is connected to the wireless data transmission system mounted on the pivot. In addition, in the part of the drilling apparatus that carries out the wireless signal transmission, repeater pipes are installed with intensifiers, carrying a source of current, between the coils of the coupling and nipple. While the drilling pipes are being inserted into the borehole, before each subsequent pipe plug consisting of three pipes is installed, the performance of the electronic assembly and inclinometer is checked using a probe that imitates the electronic assembly's command signal and ensuring the reception and display of data from the electronic assembly.

The proposed drilling method is shown in Figure 1.

The essence of the method is as follows. In the first stage of drilling, the vertical borehole shaft is drilled using any known method (rotary using pipe-drill or face engine with propeller).

The drilling apparatus for the oblique and horizontal boreholes is then prepared. It consists of a bit 1, face engine 2, oblique transfer device 3 and alighting gear. The apparatus also includes regular drilling pipes 4. Into these pipes, on the geophysical cable 5, the borehole device or inclinometer 6 is inserted. The part of the apparatus consisting of regular drilling pipes 4 is completed by the lower pipe transfer device 7. Inside the lower pipe transfer device 7 the electronic assembly is placed, allowing the reception and transmission of signals between the inclinometer 6 and the surface operator's console 8. The lower lead-in of the assembly is connected to the upper joint of the geophysical cable 5 coming from the inclinometer 6. The upper lead-in of the electronic assembly is connected to the wireless surface data transmission system (3, 4).

When oblique and horizontal borehole sections are drilled, the drilling apparatus above the pipe transfer device 7 consists of special drilling pipes 9 with antenna transfer, allowing wireless

15-17). Here, the windings 6 may be placed obliquely in the channels 7 (Figure 15) or in internal closed magnetic circuits 14 (Figure 16).

If the nipple butt and the opposite surface of the coupling are used as supports in the lock between adjoining tubes (in which case a gap will be evident at the coupling butt), the transformer windings 6 in the channels 7 may be placed in internal closed circular magnetic circuits 15 similar to those in Figure 10. In this case, in order to obtain a reliable closed conductive circuit, the inner parts of the nipple and coupling must protrude (Figure 17).

When the tubes' internal conductivity is insufficient, the winding 6 in the magnetic circuit 15 must be placed in an additional circular closed conductive core 17, the unconnected couplings of which ~~protrude above the adjoining surface (Figure 9). If a conductive tube and a non-conductive tube then~~ join, only one winding must be placed in the unconnected conductive core, corresponding to the circular channel of the non-conductive tube. The second winding is positioned in the circular channel of the conductive tube, without additional core.

In addition to the versions examined, the transformer windings 6 in the electrical transmission system may be placed in circular channels 7 in the outer cylindrical surfaces 21 of the nipple 1 and coupling 3 (Figures 18-20). The parts of the outer cylindrical surface 21 of the adjoining tubes 2 and 4 behind the circular channels 7 from the tube join 22 are linked to an additional outer magnetic circuit 23. Figure 18 indicates a version in which the outer diameter of the outer magnetic circuit 23 is greater than that of the adjoining tubes. Figure 19 shows a version in which the outer diameter of the outer magnetic circuit 23 equals that of the adjoining tubes.

A third version is possible, with the outer diameter of the outer magnetic circuit less than that of the adjoining tubes. Figure 20 indicates a transmission system in which the transformer windings 6 are wound around internal closed circular magnetic circuits 15 and the assembly is positioned in the channels 7 in the outer cylindrical surfaces 21 of the nipple 1 and coupling 3. Here, the outer element 23 must consist of electrically conductive material.

A version is suggested in which the transformer windings 6 of the electrical transmission system are positioned in the circular channels 7, which are on the inner cylindrical surfaces 24 of the nipple 1 and coupling 3 (Figures 21-23). Here, the sections of the inner cylindrical surface 24 of the adjoining tubes 2 and 4, behind the circular channels 7 from the tube joint, are linked to an additional magnetic circuit 25 placed within the tubes. Figure 21 indicates a version in which the inner diameter of the additional magnetic circuit 25 is less than the inner diameter of the adjoining tubes. Figure 22 indicates a version in which the inner diameter of the additional magnetic circuit equals that of the adjoining tubes. Figure 23 indicates a version of the transmission system similar to that in Figure 20. Here also, the additional magnetic circuit 25 must consist of electrically conductive material.

The electrical conductors in the transmission system may also take the form of metallic strips 26 strengthened by flexible ribbon 27 (Figures 24, 25). Here, the flexible ribbon 27 is insulated from the surface 28 of the tube 4, and also insulated from the inner cavity of the tube or the outside (where the ribbon is positioned on the outer surface of the tube) by a covering 29.

To examine the principle of activity of the system proposed, it is permissible for the tube 2 to contain a supply unit, a command production unit and an information-processing unit, and for the tube 4 to contain a sensor unit.

The supply (energy), in the form of alternating current passed at a frequency *f* through the electrical conductors 8, enters the transformer winding 6 fixed in the nipple 1 (Figure 1). In the second transformer winding 6, fixed in the coupling 3, is an alternating current that goes to supply the sensor unit, passing through the conductors 8 situated in the tube 4.

If the tubes 2 and 4 consist of magnetic material, the two windings 6 shall form a transformer with ferromagnetic core. If the adjoining tubes consist of non-magnetic material, the two windings 6 shall form a transformer without magnetic circuit (aerial transformer).

The unconnected magnetic circuits 14 form, together with the windings 6, a transformer with ferromagnetic core (Figure 4), regardless of whether the adjoining pipes consist of magnetic or non-magnetic material.

The closed circular magnetic circuits 15 form, together with the windings 6 and the conductive nipple 1 and the coupling 3, a transformer with a short-circuited screw (corpus) (Figure 5).

Information passed from the sensor unit to the processing unit as an alternating current signal or impulse signal follows the same route as the supply voltage, but in a reverse direction.

Information passed from the command-processing unit to the sensor unit as an impulse signal follows the same route as the supply voltage.

For simultaneous transmission of information on supply voltage and other information, the frequency *f2* of the information signal in the form of alternating current must differ from the frequency *f1* of the supply voltage, or else the information signal must take the form of impulses.

connected to the cable passing within the square mounted in the drilling apparatus above the upper pipe transfer device, above which the exit pipe transfer device with lectronic assembly mounted inside is installed, allowing the reception and transmission of signals. The lower lead-in of the assembly is connected to the upper joint of the cable passing within the square, and the upper lead-in is connected to the wireless data transmission system mounted on the pivot.

2. A method as per 1, *distinguished in that* in the part of the drilling apparatus allowing wireless signal transmission, repeater pipes are installed with intensifiers with a source of current between the coils on the nipple and coupling.

3. A method as per 1, distinguished in that when the drilling pipes are inserted into the borehole, the performance of the electronic assembly and inclinometer are checked before each subsequent pipe plug (consisting of three pipes) is installed, using a probe that imitates the electronic assembly's command signal and allowing data to be received and transmitted from the electronic assembly.

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(19) RU (11) 2140537 (13) C1

(51) 6 E 21 B 47/022, 7/04



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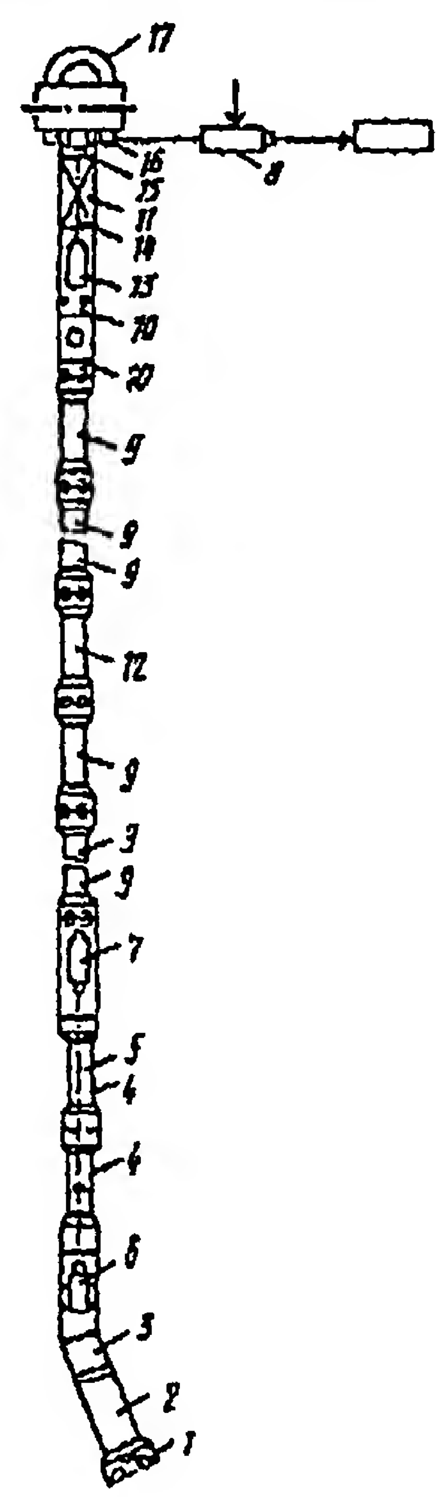
(54) СПОСОБ БУРЕНИЯ НАКЛОННЫХ И ГОРИЗОНТАЛЬНЫХ СКВАЖИН

(57) Изобретение относится к технике проходки и измерения текущих координат забоя наклонных и горизонтальных скважин

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(12°) Description of the Invention (for which a Russian patent is being requested)
(19°) RU (11°) 2140537 (13°) C1
(51°) 6 E 21 B 47/022, 7/04

The All-Russian Technical and Patents Library
9 November 1999

(21°) 97121250/03
(22°) 18.12.1997
(24°) 18.12.1997
(46°) 27.10.1999 Bulletin No 30
(72°) Yu. M. Basarygin, V. F. Budnikov, V. G. Geras'kin, S. F. Konovalov, P. P. Makarenko, V. M. Strel'tsov, V. M. Sugak, A. M. Chernenko, and A. V. Polyakov.

(71°) (73°) "Kuban'gazprom"

(56°) RU 20789212 C1 (10.05.1997), SU 141555 A (02.12.1961), SU 259773 A (04.05.1970), SU 471427 A (01.09.1975), SU 1141187 A (23.02.1985), SU 1640384 A1 (07.04.1991), SU 1490268 A1 (30.06.1989), RU 2040691 C1 (27.07.1995), RU 2055178 C1 (27.02.1996), US 4806928 A (21.02.1989), US 5042597 A (27.08.1996), US 5341886 A (30.08.1994), DE 3912614 A1 (02.11.1989), DE 3428931 A1 (05.06.1985).

(98°) NTCP Kuban'gazprom, Ulitsa Mira 34, 350063 Krasnodar

(54°) A method for drilling oblique and horizontal boreholes

(57°) The invention relates to the technique of cutting and of measuring the regular face co-ordinates of oblique and horizontal boreholes during drilling. The task of the invention is to increase the reliability of drilling. The method consists of drilling a vertical borehole and installing alighting gear, an oblique transfer device and a face engine in the drilling apparatus at the point of curvature. An inclinometer is inserted in the pipes in the apparatus using geophysical cable, and fixed in the alighting gear. The oblique and horizontal parts of the borehole are drilled by regular rotary drilling using the face engine, and the regular face co-ordinates are monitored using data from the inclinometer. After the inclinometer is inserted and fixed in the alighting gear, the lower pipe conductor is mounted together with the electronic assembly positioned within. The lower lead-in of the assembly is connected to the upper joint of the cable coming from the inclinometer, and the upper lead-in to the wireless surface data transmission system. In the last section, drilling pipes and a balloon-screen with electric coils, placed in the nipples and couplings of the locks and linked to each other by wire attached to the body of the pipes and the balloon-screen, are used. Above the balloon-screen the upper pipe conductor, with an electronic assembly positioned inside, is mounted. Its lower lead-in is connected to the wireless data transmission system, and the upper lead-in is connected to the cable passing inside the square. Above the square the exit pipe transfer device is installed, with an electronic assembly positioned inside. The lower lead-in of the assembly is connected to the upper joint of the cable passing inside the square, and the upper lead-in to the wireless data transmission system mounted on the swivel.

The invention relates to the drilling of boreholes and specifically to methods of cutting and of measuring regular face co-ordinates in oblique and horizontal boreholes during drilling.

The prior art relates to methods of drilling oblique and horizontal boreholes (1). This art consists of drilling a vertical borehole shaft, installing an oblique transfer device, a face engine and a system for measuring the borehole profile during drilling (the MWD system) in the drilling apparatus at the point of curvature, drilling the oblique and horizontal parts of the well by regular rotary drilling, drilling using the face engine, and monitoring the regular co-ordinates of the borehole according to the data from the MWD system inclinometer.

This system has the following fundamental disadvantages:

- insufficient data transfer speed (6-8 seconds to transfer one parameter);
- work using aerated drilling solutions is impossible.

The closest method in terms of technical features and results available consists of drilling oblique and horizontal boreholes while drilling vertical borehole shafts, installing a face engine and an oblique transfer device in the drilling apparatus at the point of curvature, inserting an inclinometer into the pipes using geophysical cable and fixing it in the lower part of the drilling apparatus, drilling the oblique and horizontal parts of the borehole by regular rotary drilling, drilling using a face engine, and monitoring the borehole face co-ordinates according to the data from the inclinometer (2).

The disadvantages of the prior art are as follows:

- the need to draw the geophysical cable behind the pipe through the cable conductor at the point of curvature creates a danger of the cable crumpling or breaking;
- the presence of the cable behind the pipe does not allow rotary drilling;
- the presence of the cable behind the pipe does not allow reliable sealing of the borehole using preventors when accidental ejection of gas or oil occurs.

The aim of the proposed invention is to improve the reliability of drilling.

The established aim is achieved because according to the invention, when using the prior method of drilling oblique and horizontal boreholes by drilling the vertical borehole shaft, installing a face engine, an oblique transfer device and alighting gear in the drilling apparatus at the point of curvature, inserting the inclinometer into the pipes in the apparatus using geophysical cable and fixing it in the alighting gear, drilling the oblique and horizontal parts of the borehole and monitoring the regular co-ordinates of the borehole face by data from the inclinometer, the lower pipe transfer device with the electronic assembly inside is mounted in the apparatus after the inclinometer is inserted and fixed into the alighting gear, allowing signals to be received and transmitted. In this way the lower lead-in of the assembly is connected to the upper joint of the cable coming from the inclinometer, and the upper lead-in is connected to the wireless data transmission system, in which drilling pipes and a balloon-screen with electrical coils (placed in the nipples and couplings of the locks and linked to each other by wire attached to the body of the pipes and the balloon-screen) are used. Above the balloon-screen installed in the drilling gear, the upper pipe transfer device with the electronic assembly positioned inside is mounted, thus allowing signals to be received and transmitted. In this case its lower lead-in is connected to the wireless data transmission system and the upper lead-in to the cable passing inside the square positioned in the drilling apparatus above the upper pipe transfer device, above which an exit pipe transfer device with an electronic assembly is installed, thus allowing signals to be received and transmitted. The lower lead-in of the assembly is thus connected to the upper joint of the cable passing within the square, and the upper lead-in is connected to the wireless data transmission system mounted on the pivot. In addition, in the part of the drilling apparatus that carries out the wireless signal transmission, repeater pipes are installed with intensifiers, carrying a source of current, between the coils of the coupling and nipple. While the drilling pipes are being inserted into the borehole, before each subsequent pipe plug consisting of three pipes is installed, the performance of the electronic assembly and inclinometer is checked using a probe that imitates the electronic assembly's command signal and ensuring the reception and display of data from the electronic assembly.

The proposed drilling method is shown in Figure 1.

The essence of the method is as follows. In the first stage of drilling, the vertical borehole shaft is drilled using any known method (rotary using pipe-drill or face engine with propeller).

The drilling apparatus for the oblique and horizontal boreholes is then prepared. It consists of a bit 1, face engine 2, oblique transfer device 3 and alighting gear. The apparatus also includes regular drilling pipes 4. Into these pipes, on the geophysical cable 5, the borehole device or inclinometer 6 is inserted. The part of the apparatus consisting of regular drilling pipes 4 is completed by the lower pipe transfer device 7. Inside the lower pipe transfer device 7 the electronic assembly is placed, allowing the reception and transmission of signals between the inclinometer 6 and the surface operator's console 8. The lower lead-in of the assembly is connected to the upper joint of the geophysical cable 5 coming from the inclinometer 6. The upper lead-in of th electronic assembly is connected to the wireless surface data transmission system (3, 4).

When oblique and horizontal borehole sections are drilled, the drilling apparatus above the pipe transfer device 7 consists of special drilling pipes 9 with antenna transfer, allowing wireless

transmission of data to the surface (3, 4). The borehole is sealed using the balloon screen 10. For rotary drilling, the square 11 is mounted in the drilling apparatus.

To complete the wireless data transmission system, the special drilling pipes 9 and balloon screen 10 with electrical coils installed in the nipples and couplings of the locks and connected to each other by wire positioned alone the body of the pipes and balloon-screen, are used.

When the drilling pipes 9 providing wireless data transmission are mounted, the performance of the electronic assembly in the pipe transfer device 7 and of the inclinometer 6 is monitored using a probe before each subsequent pipe plug (three connected drilling pipes) is installed. This probe imitates the electronic assembly's command signals and allows the reception and display of data received from the electronic assembly.

In the part of the drilling apparatus consisting of special drilling pipes 9 and allowing wireless transmission of signals, repeater pipes 12 are installed.

These repeater pipes contain a special intensifier with a source of supply between the coils of the coupling and nipple. This intensifier passes on the data travelling through the wireless transmission system. In this way, the reliability of the system is increased.

Above the balloon-screen 10 installed in the drilling apparatus, an upper pipe transfer device 13 is installed with an electronic assembly positioned inside. This assembly allows signals to be received and transmitted; the lower lead-in of the assembly is connected to the wireless data transmission system, while the upper lead-in of the assembly is connected to the cable 14 passing within the square 11.

Above the square 11, an exit pipe transfer device 15 is installed with an electronic assembly positioned inside, allowing the reception and transmission of signals. The lower lead-in of the assembly is connected to the upper joint of the cable 14 passing within the square 11, and the upper lead-in of the assembly is connected to the wireless data transmission system 16 mounted on the pivot 17.

The proposed invention allows the reliability of oblique and horizontal borehole drilling to be increased.

The proposed method requires no insertion of geophysical cable behind the pipe at the point of curvature in the borehole that follows the vertical shaft.

Sources of information:
1. Teleco Oilfield Services Inc, 1990
2. RF Patent 2078921, E 21 B 47/022, 1997 (prototype)
3. USA Patent 4806928, G 01 V 1/00, 1989
4. FRG Patent 3912614, E 21 B 47/12, 1989
5. RF Patent 2040691, E 21 B 47/12, 1992.

## FORMULA OF THE INVENTION

1. A method of drilling oblique and horizontal boreholes including a vertical borehole shaft, installing a face engine, oblique transfer device and alighting gear in the drilling apparatus at the point of curvature, inserting an inclinometer into the pipes in the apparatus by geophysical cable and fixing it in the alighting gear, drilling the oblique and horizontal parts of the borehole and monitoring the regular co-ordinates of the borehole face by the data from the inclinometer, *distinguished in that* after the inclinometer is inserted and fixed in the alighting gear, the lower pipe transfer device with the electronic assembly inside is mounted in the apparatus, allowing the reception and transmission of signals. The lower lead-in of the assembly is connected to the upper joint of the cable coming from the inclinometer, and the upper lead-in is connected to wireless surface data transmission system, in which drilling pipes and a balloon screen, with electric coils installed in the nipples and couplings of the locks between the drilling pipes and connected to each other by wire positioned along the body of the pipes and the balloon screen, are used. Above the balloon-screen installed in the drilling apparatus, an upper pipe transfer device with an electronic assembly positioned inside is mounted, allowing the reception and transmission of signals. Its lower lead-in is connected to the wireless data transmission system, and the upper lead-in is

connected to the cable passing within the square mounted in the drilling apparatus above the upper pipe transfer device, above which the exit pipe transfer device with electronic assembly mounted inside is installed, allowing the reception and transmission of signals. The lower lead-in of the assembly is connected to the upper joint of the cable passing within the square, and the upper lead-in is connected to the wireless data transmission system mounted on the pivot.

2. A method as per 1, *distinguished in that* in the part of the drilling apparatus allowing wireless signal transmission, repeater pipes are installed with intensifiers with a source of current between the coils on the nipple and coupling.

3. A method as per 1, distinguished in that when the drilling pipes are inserted into the borehole, the performance of the electronic assembly and inclinometer are checked before each subsequent pipe plug (consisting of three pipes) is installed, using a probe that imitates the electronic assembly's command signal and allowing data to be received and transmitted from the electronic assembly.

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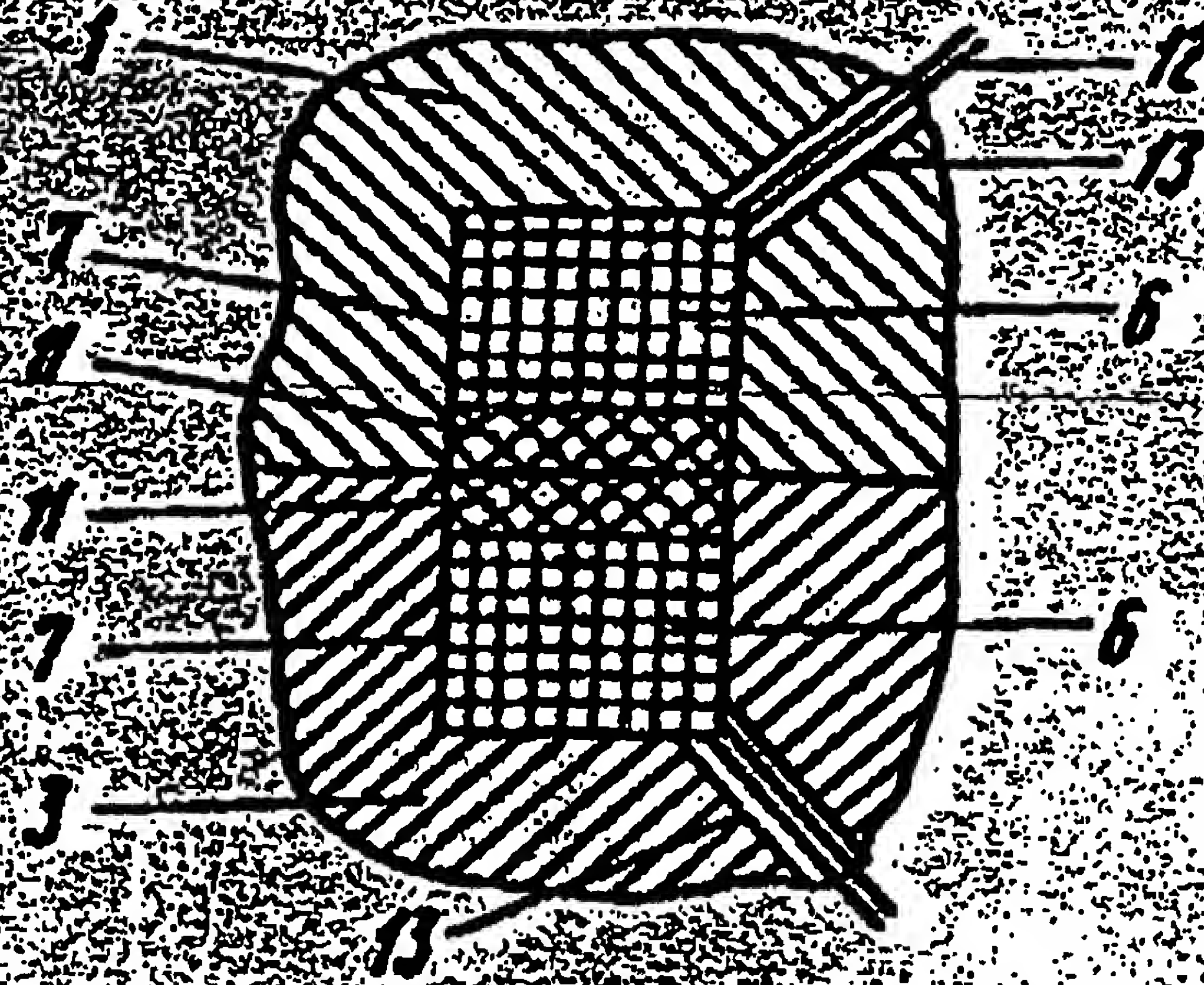


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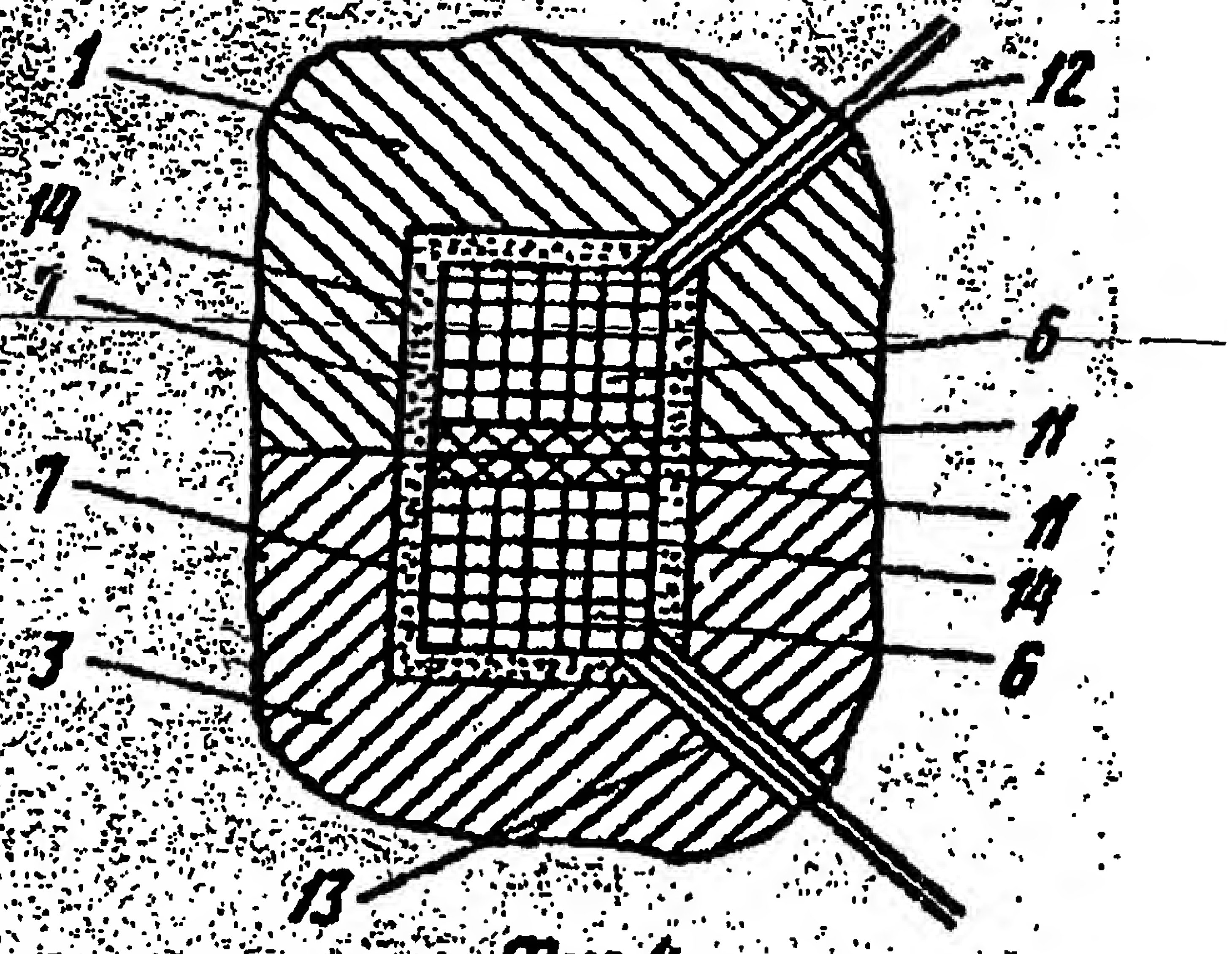


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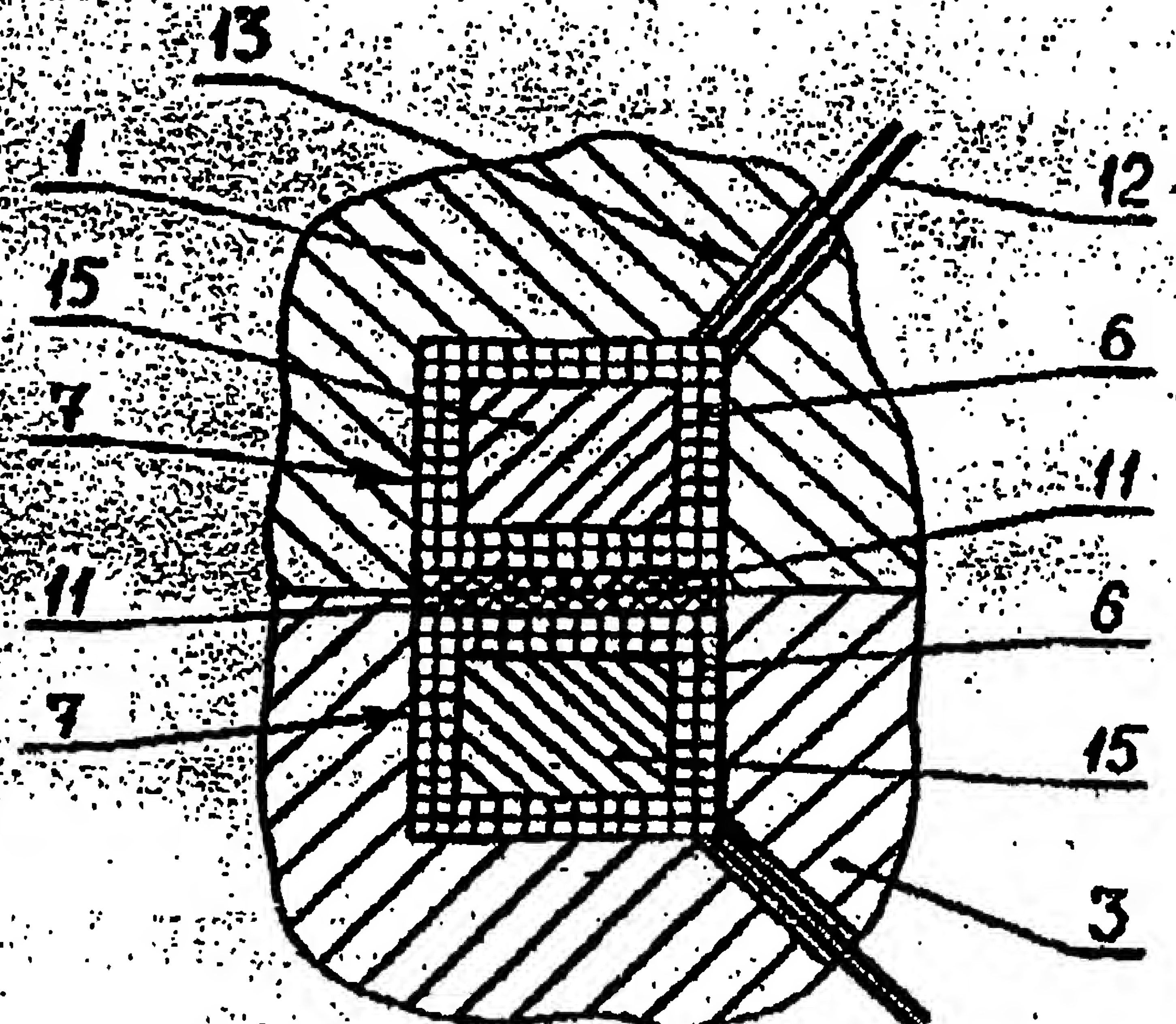


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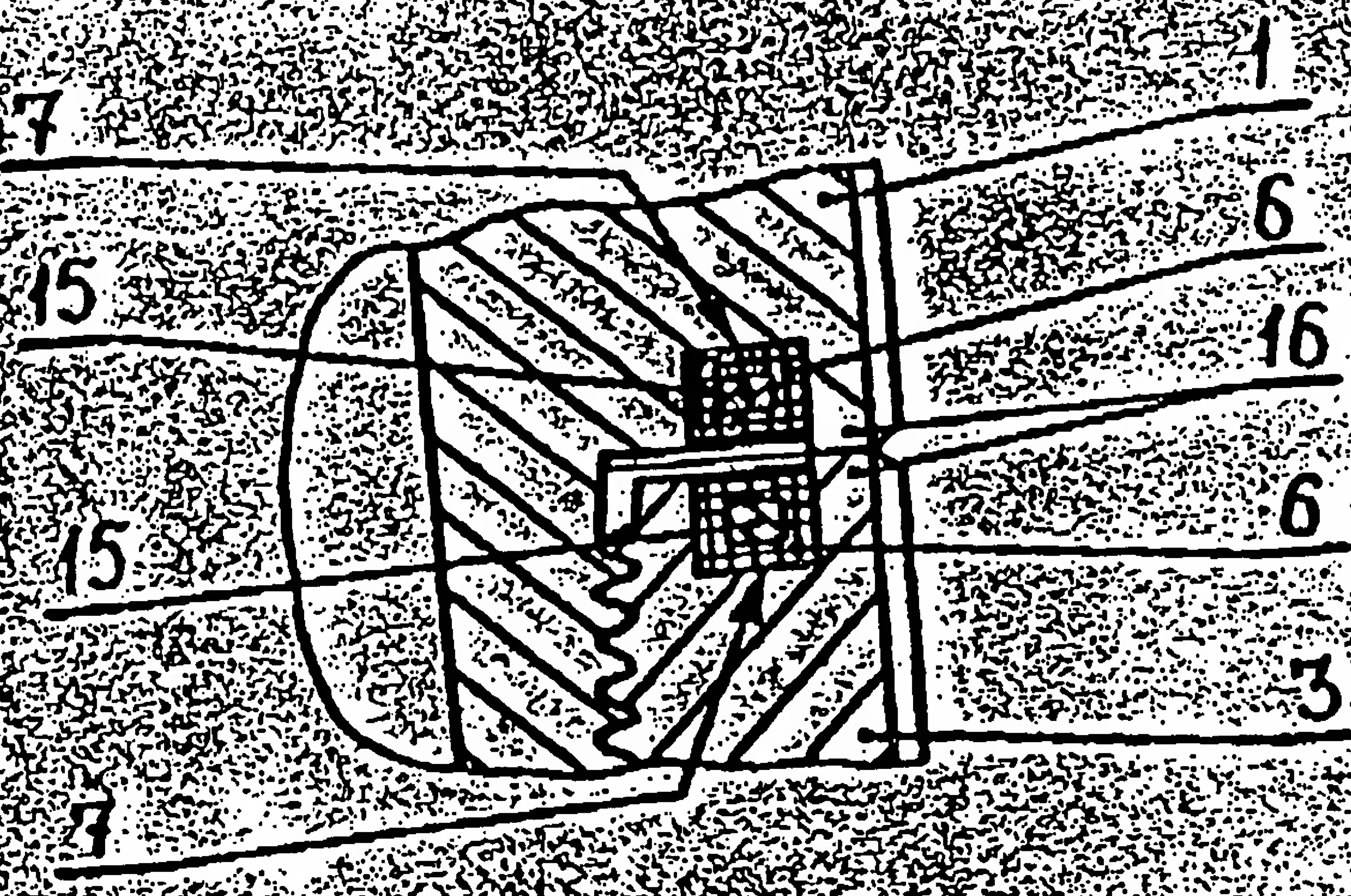


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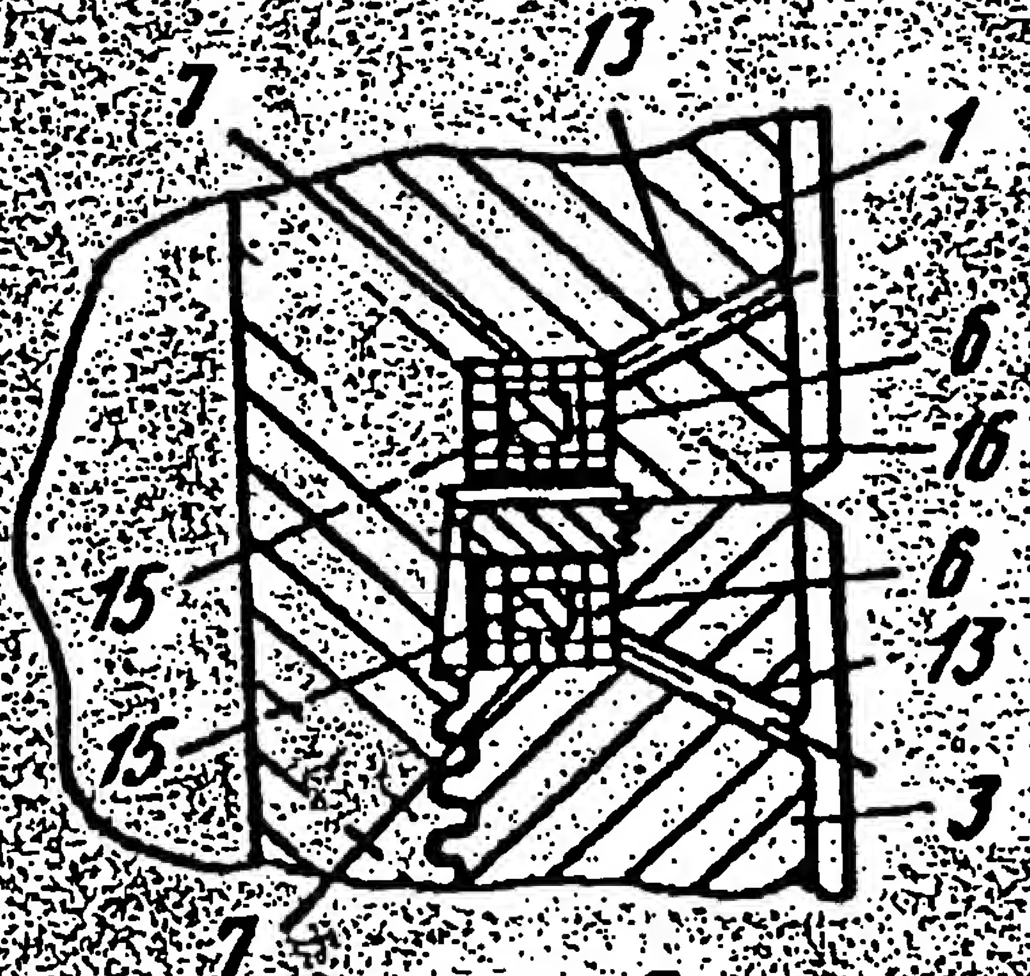


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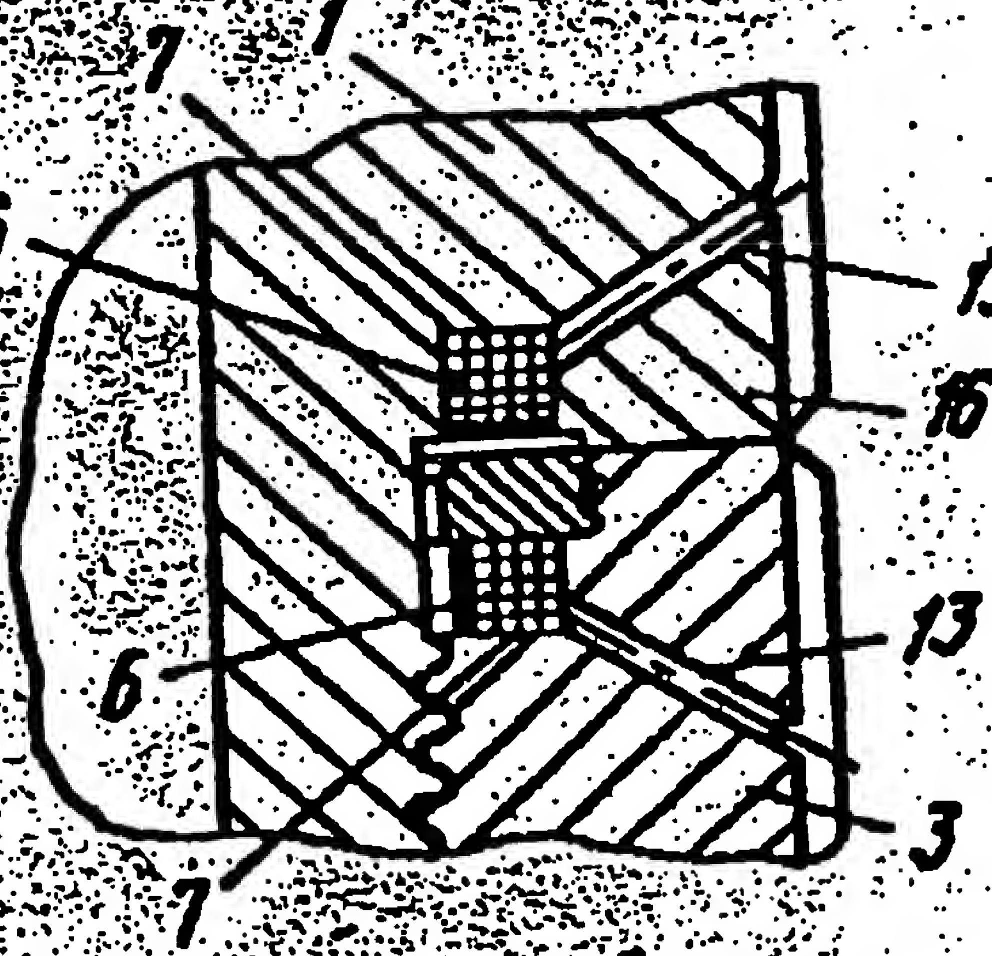


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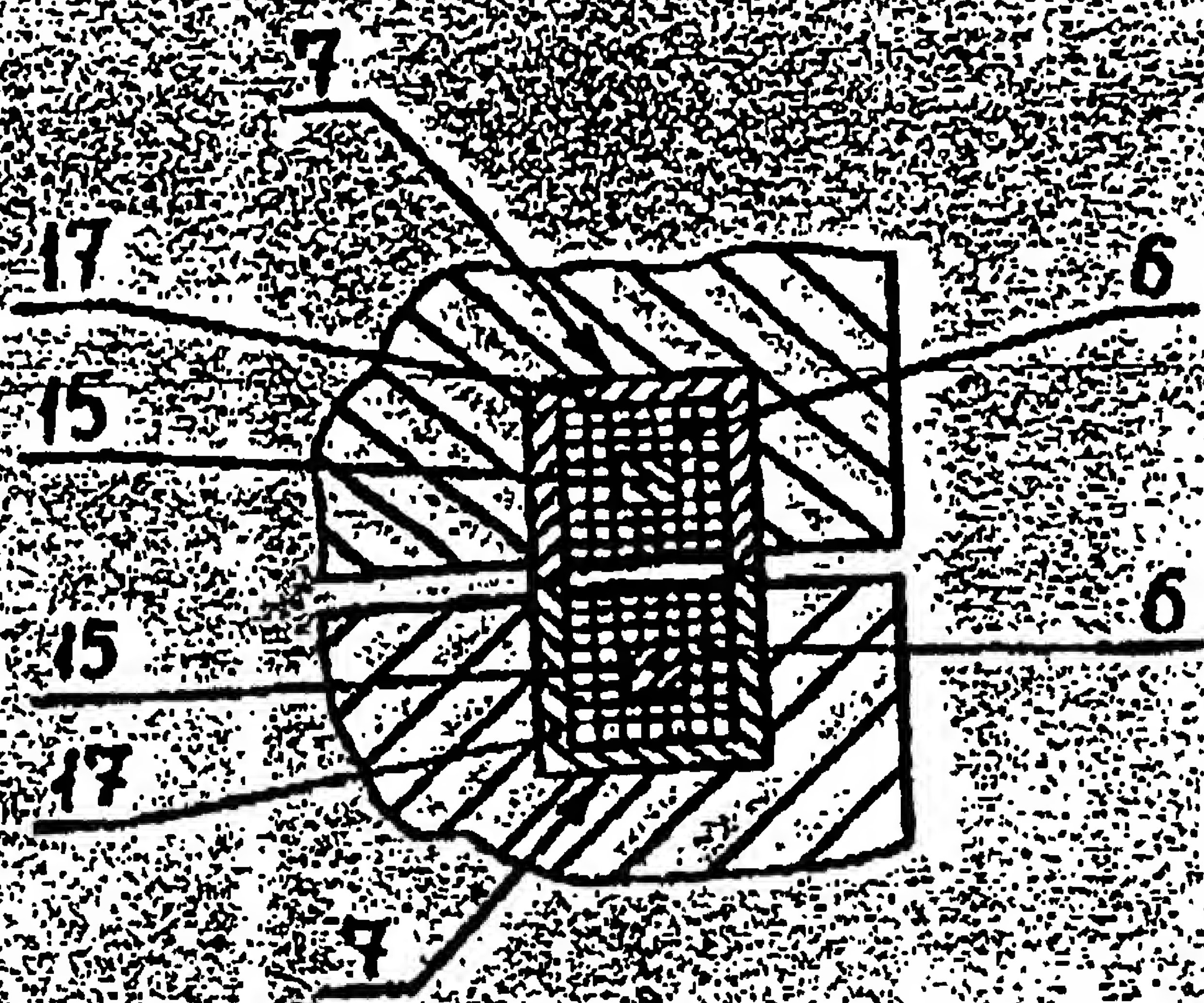


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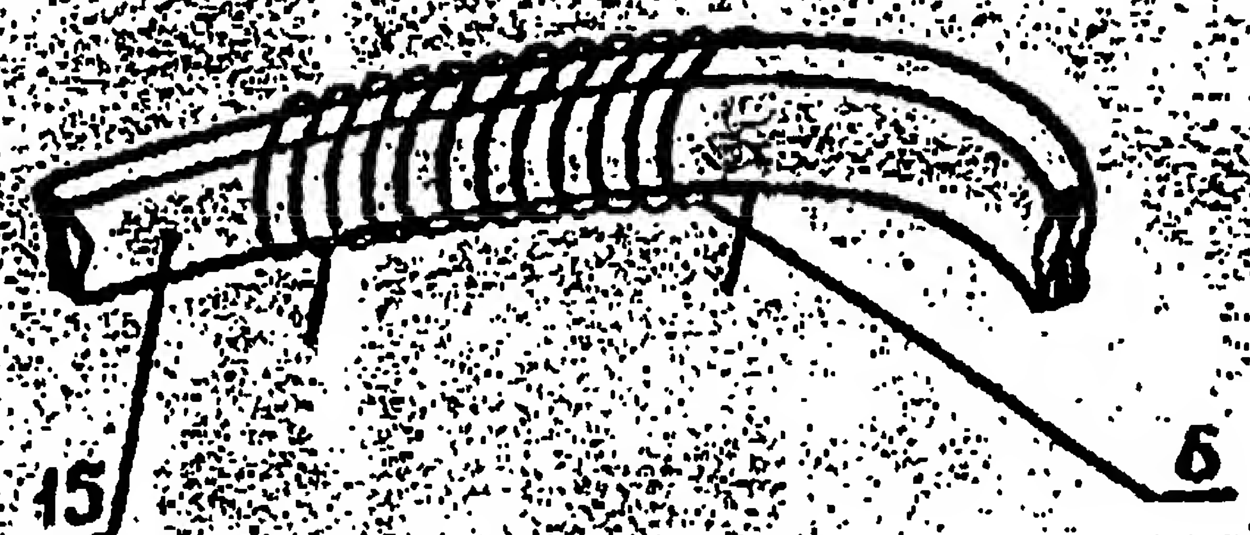


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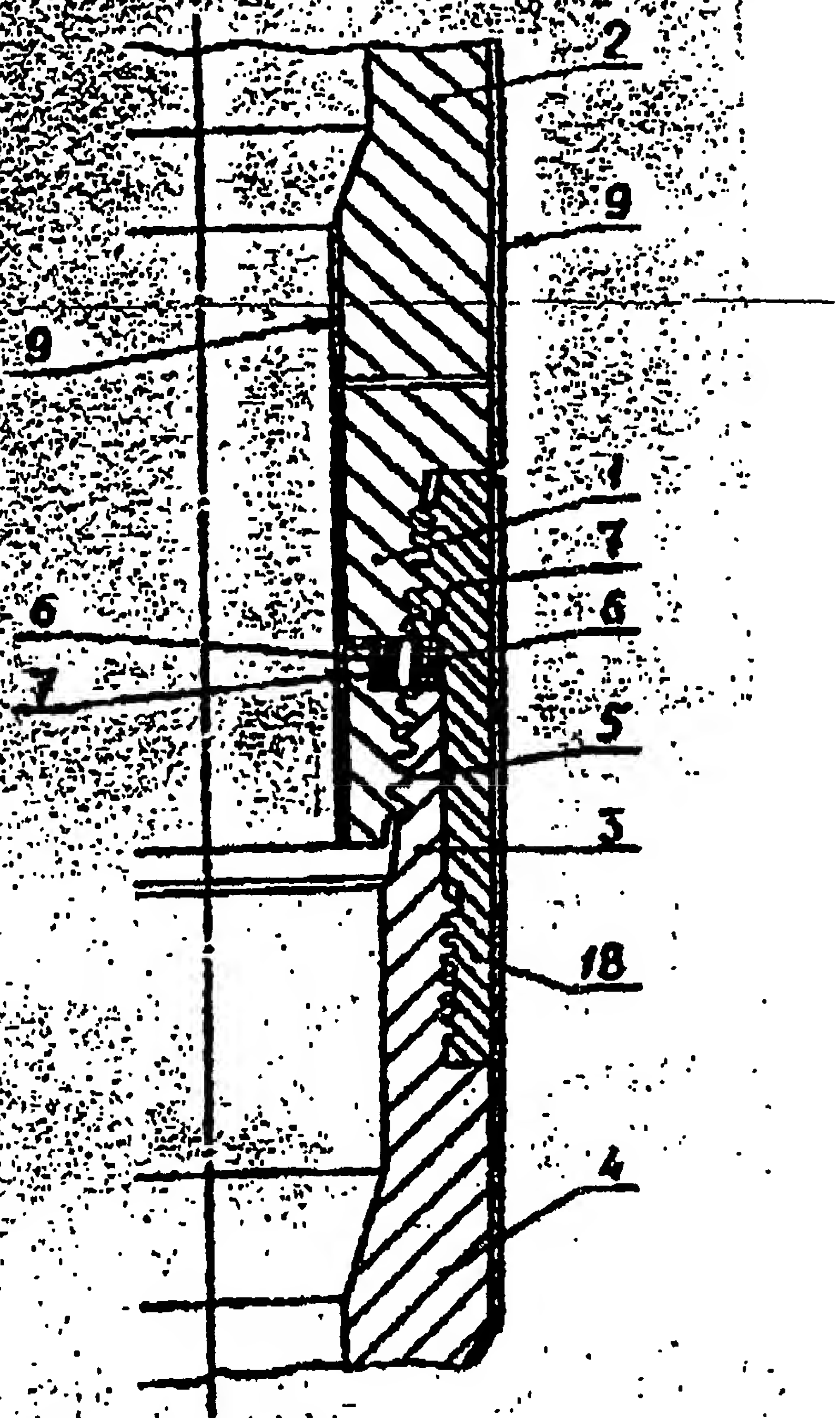


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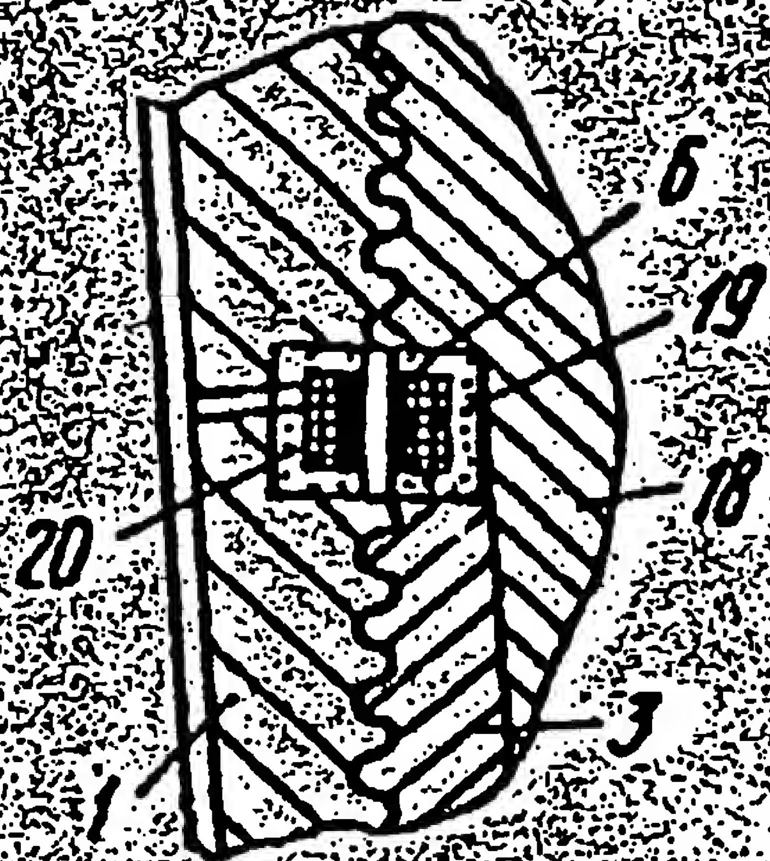
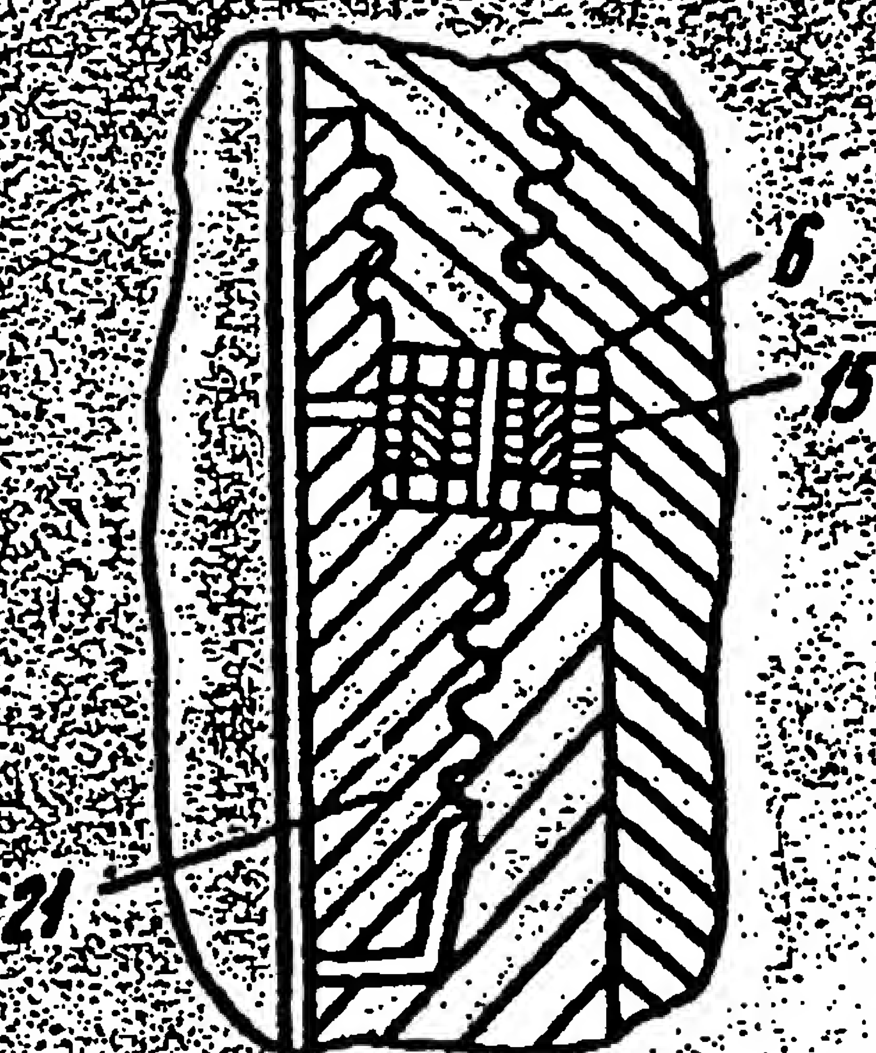



Фиг.12

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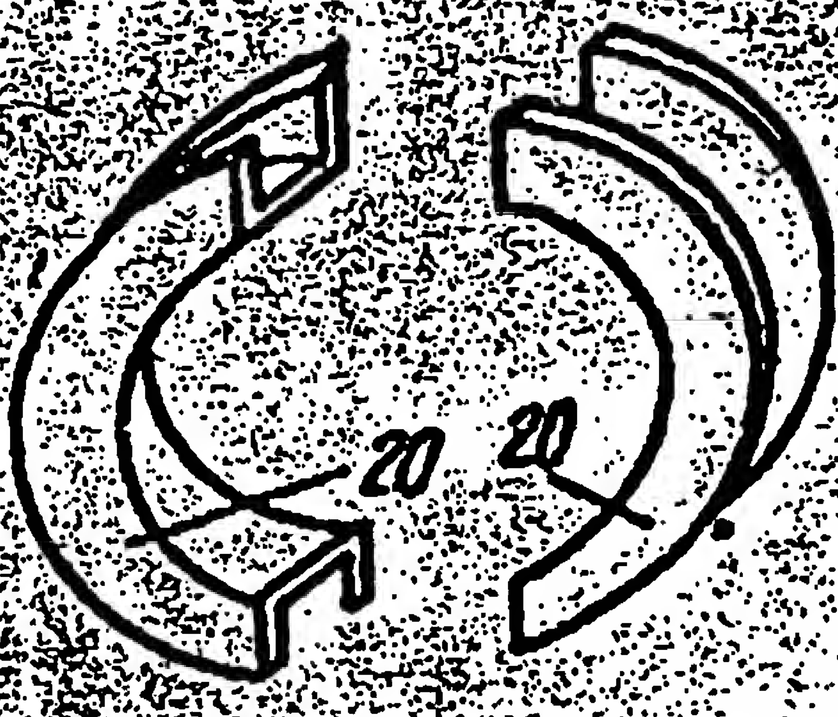


Фиг.14

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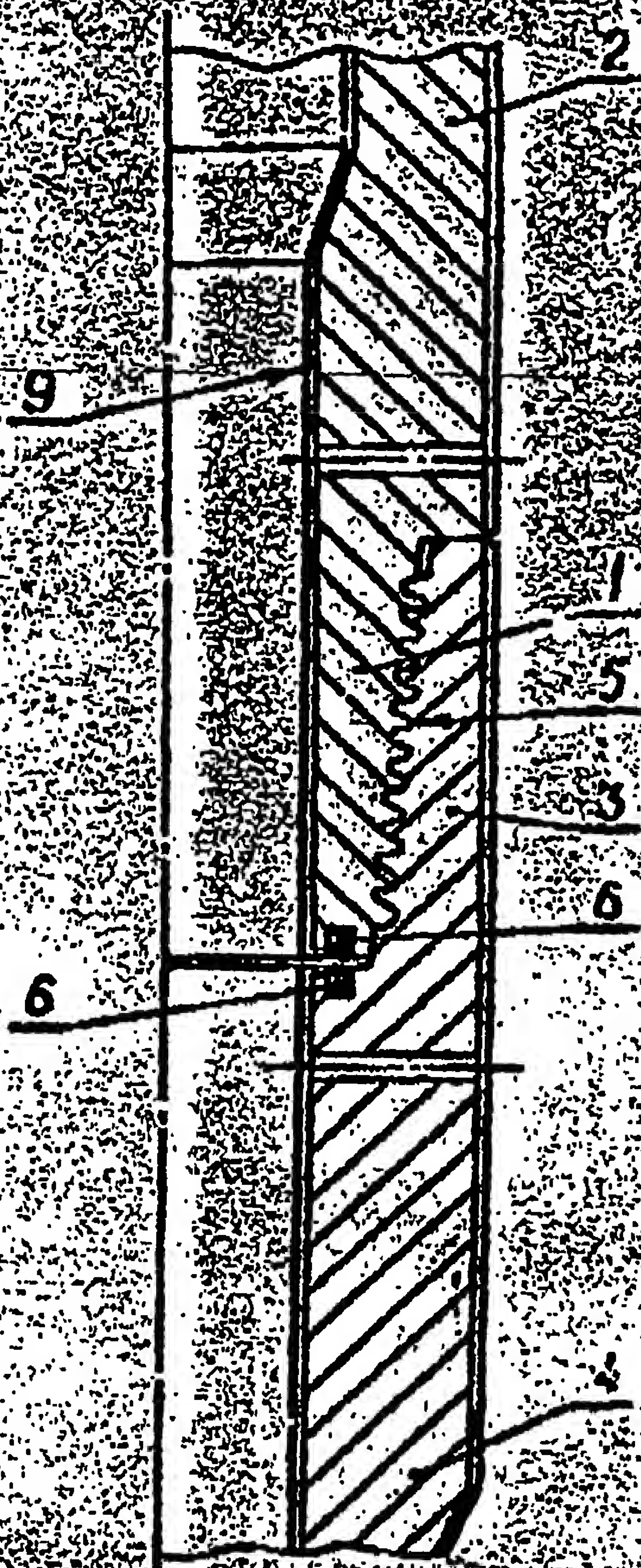


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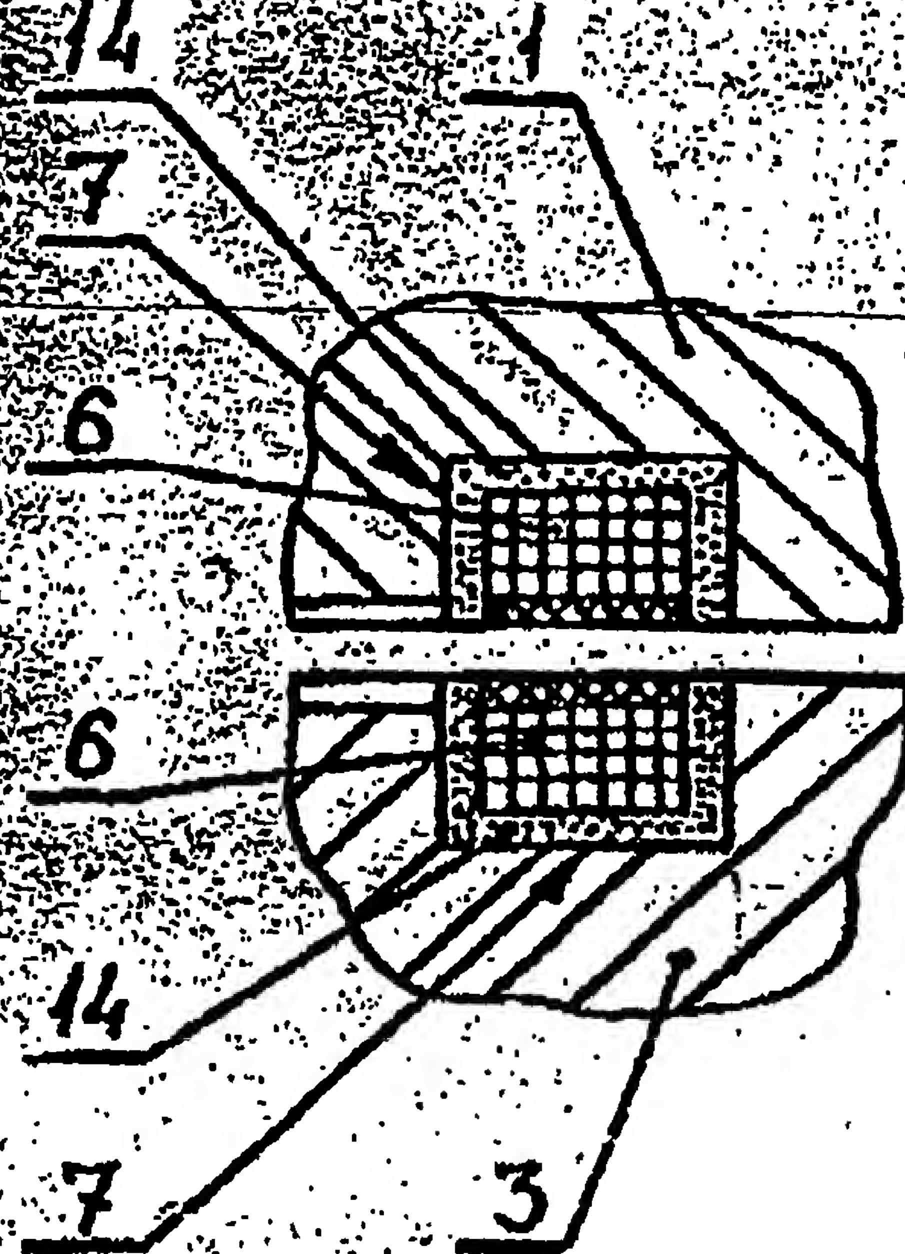


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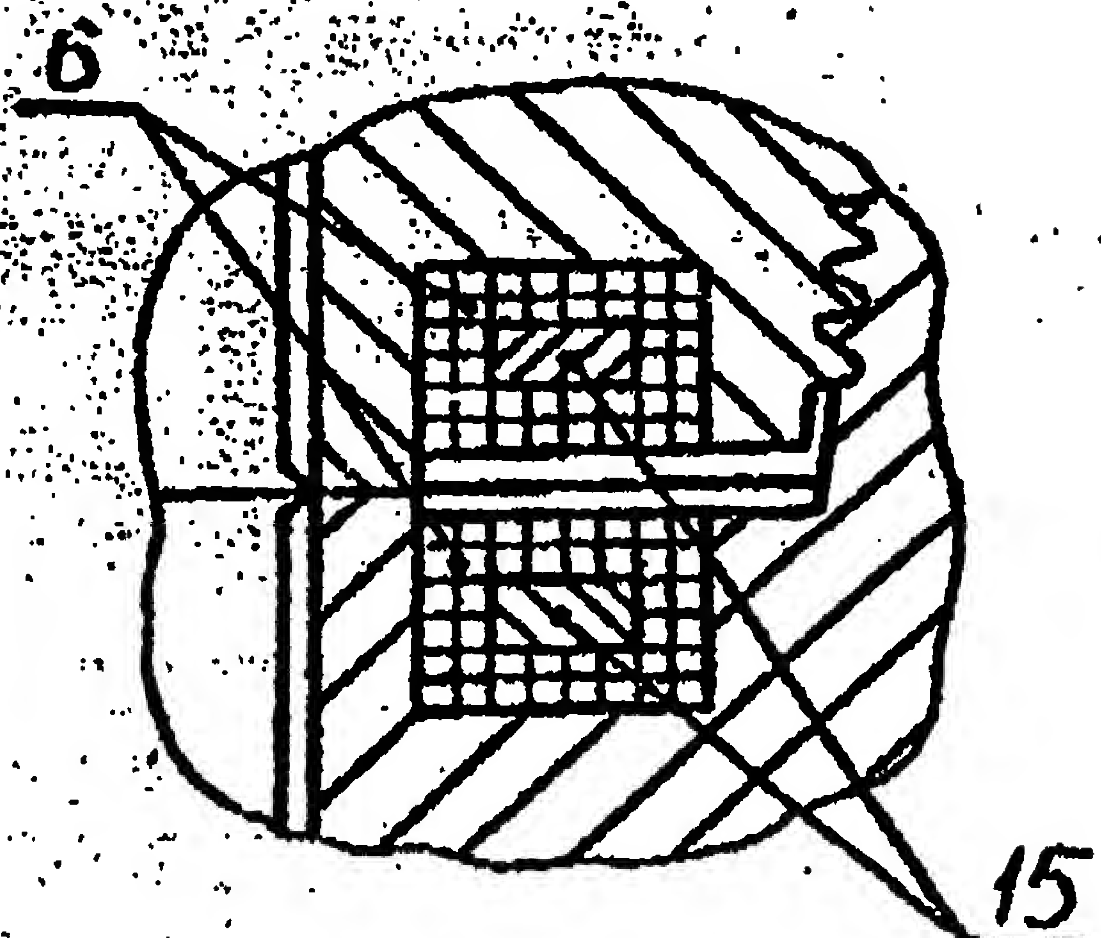


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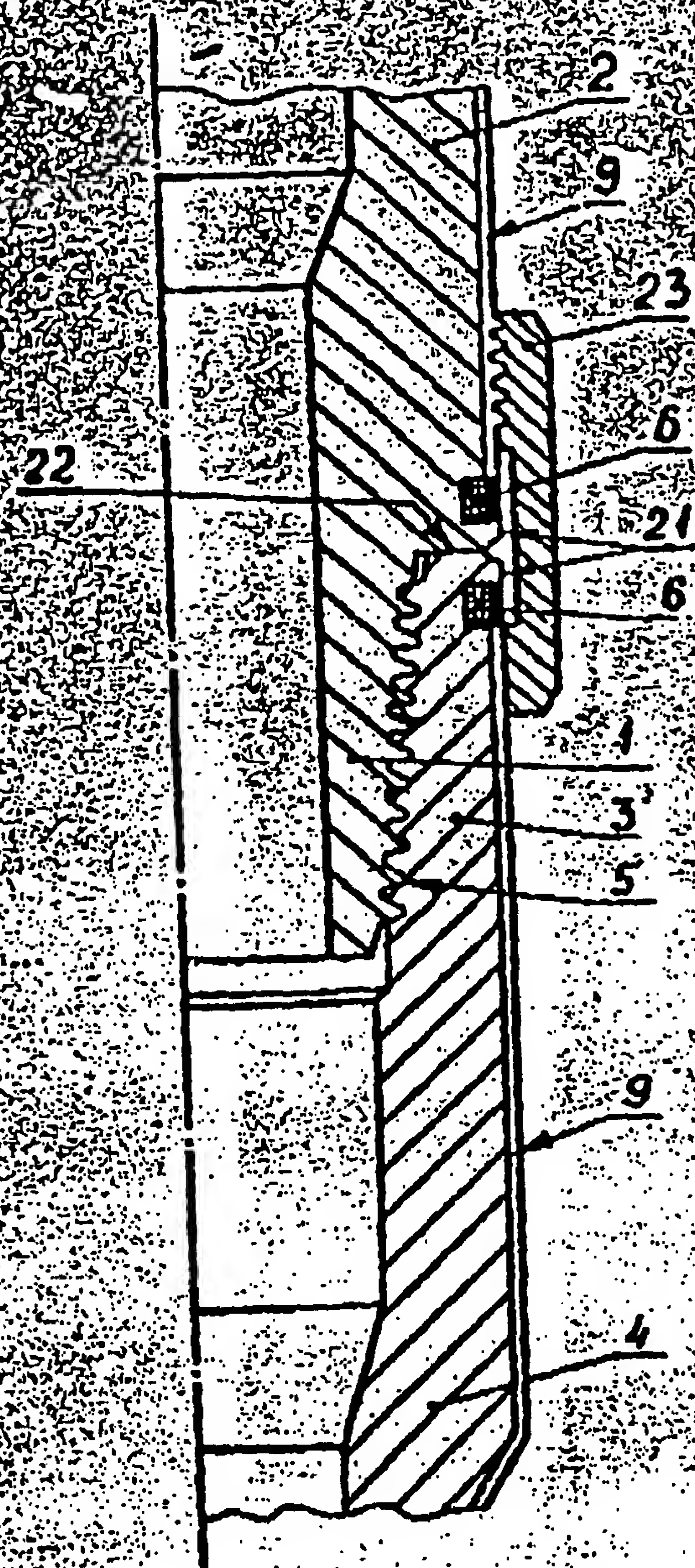


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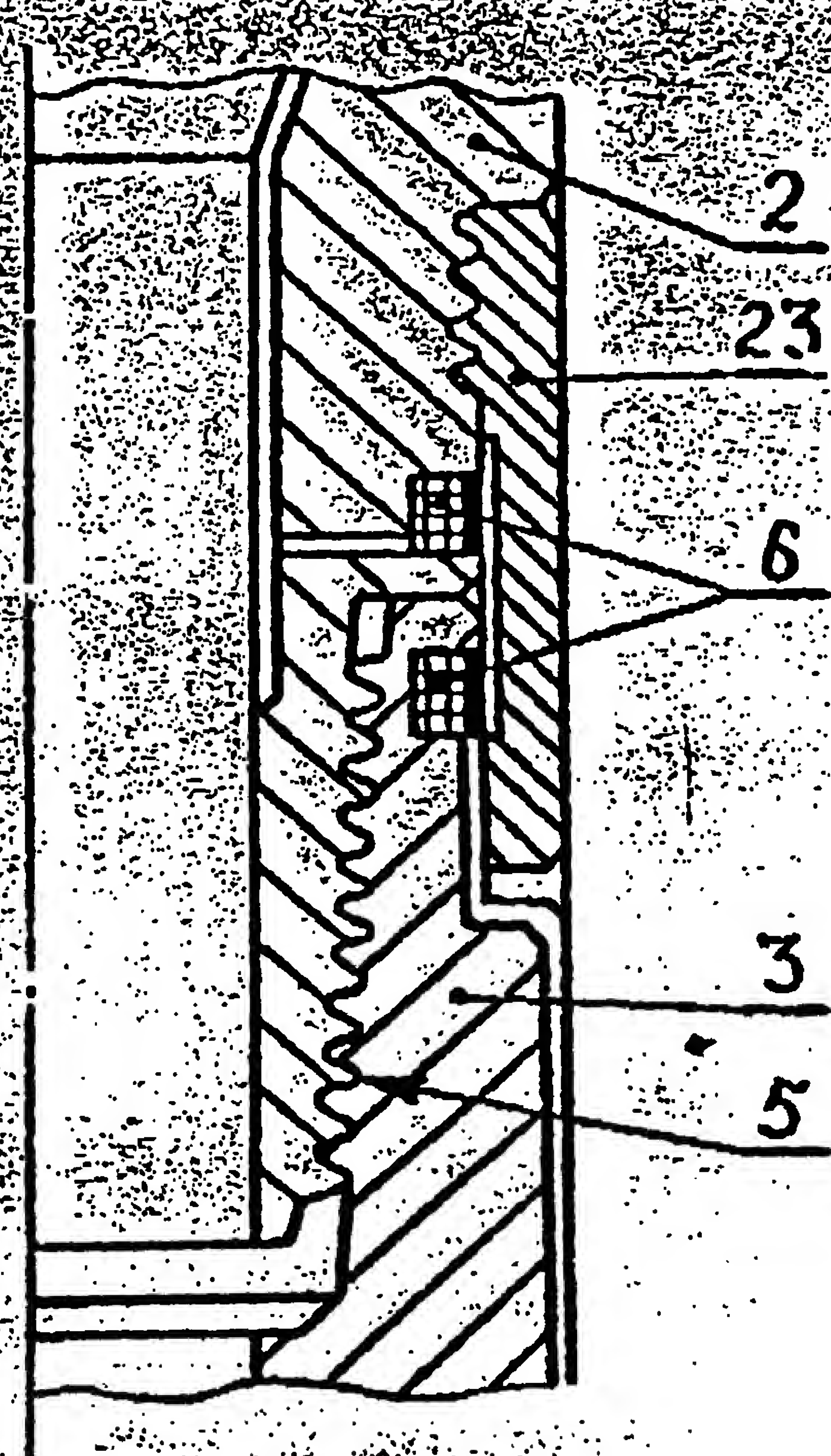


Фиг. 19

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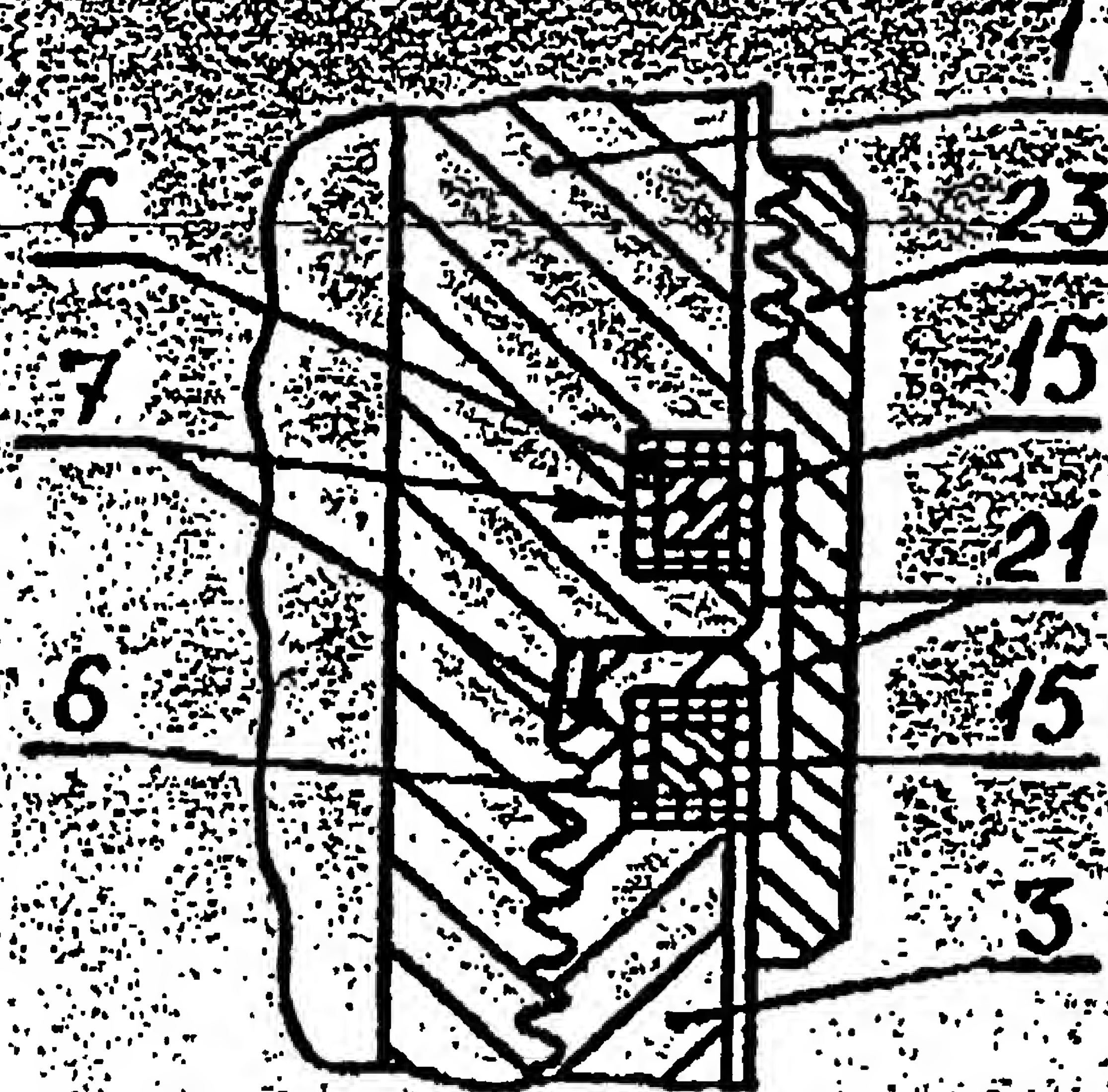


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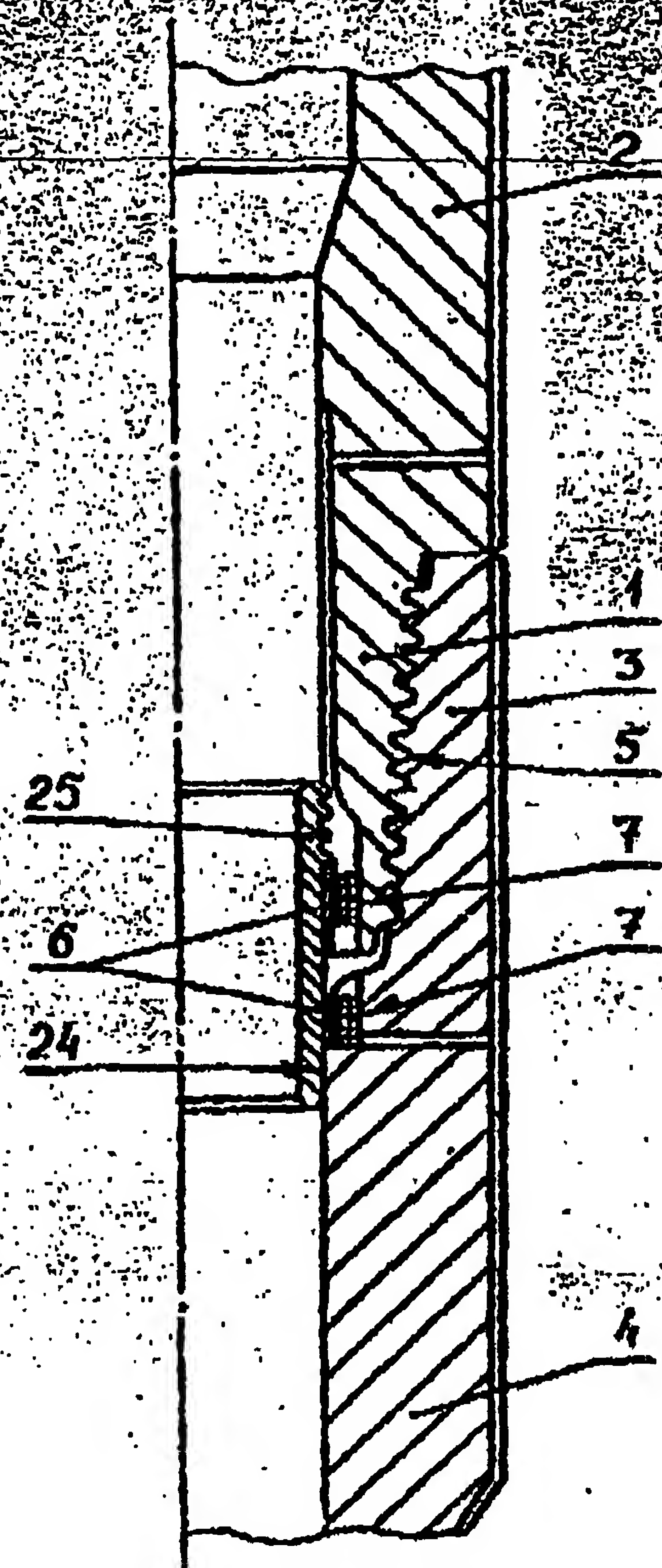
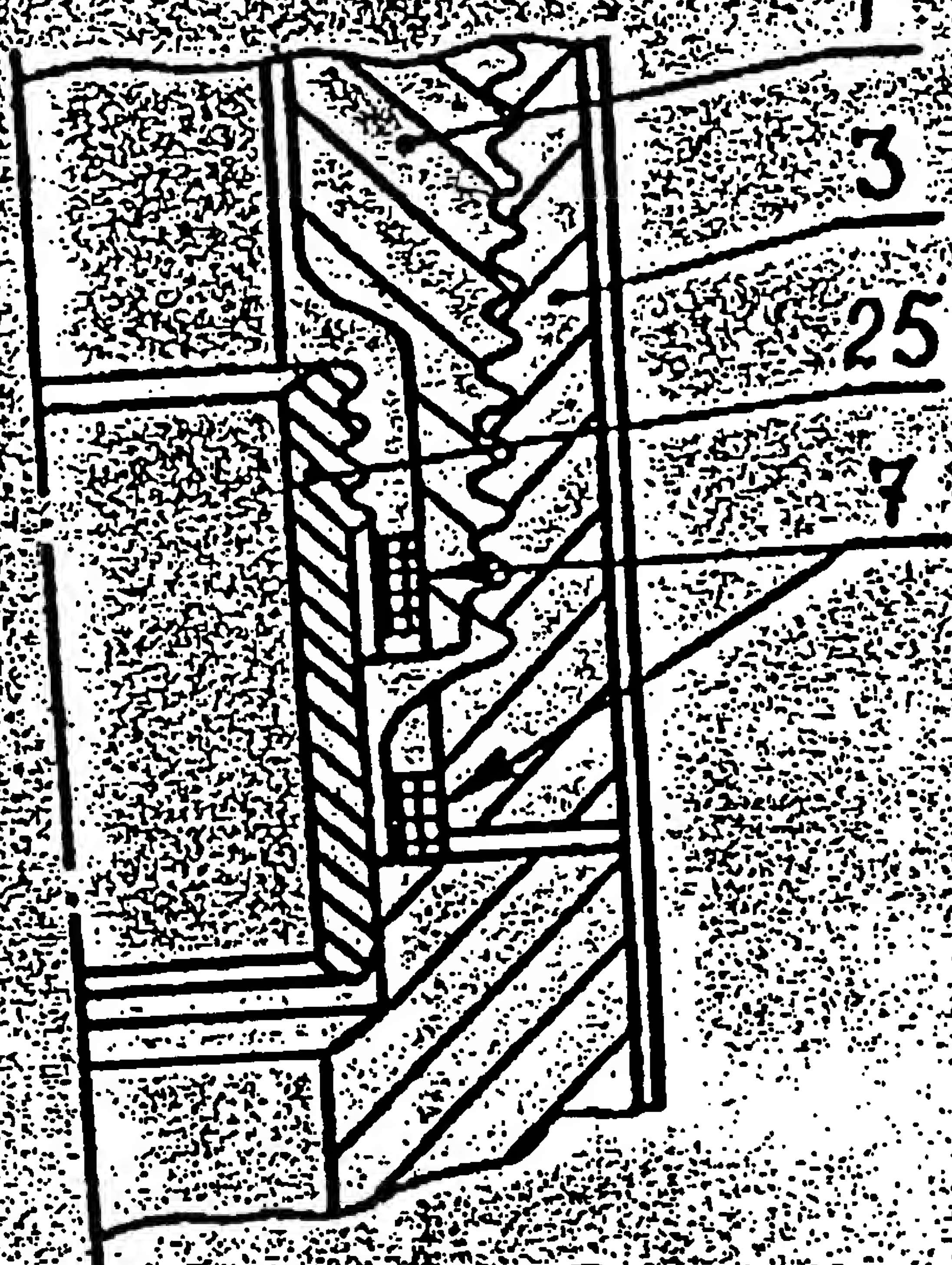



Фиг.21

12



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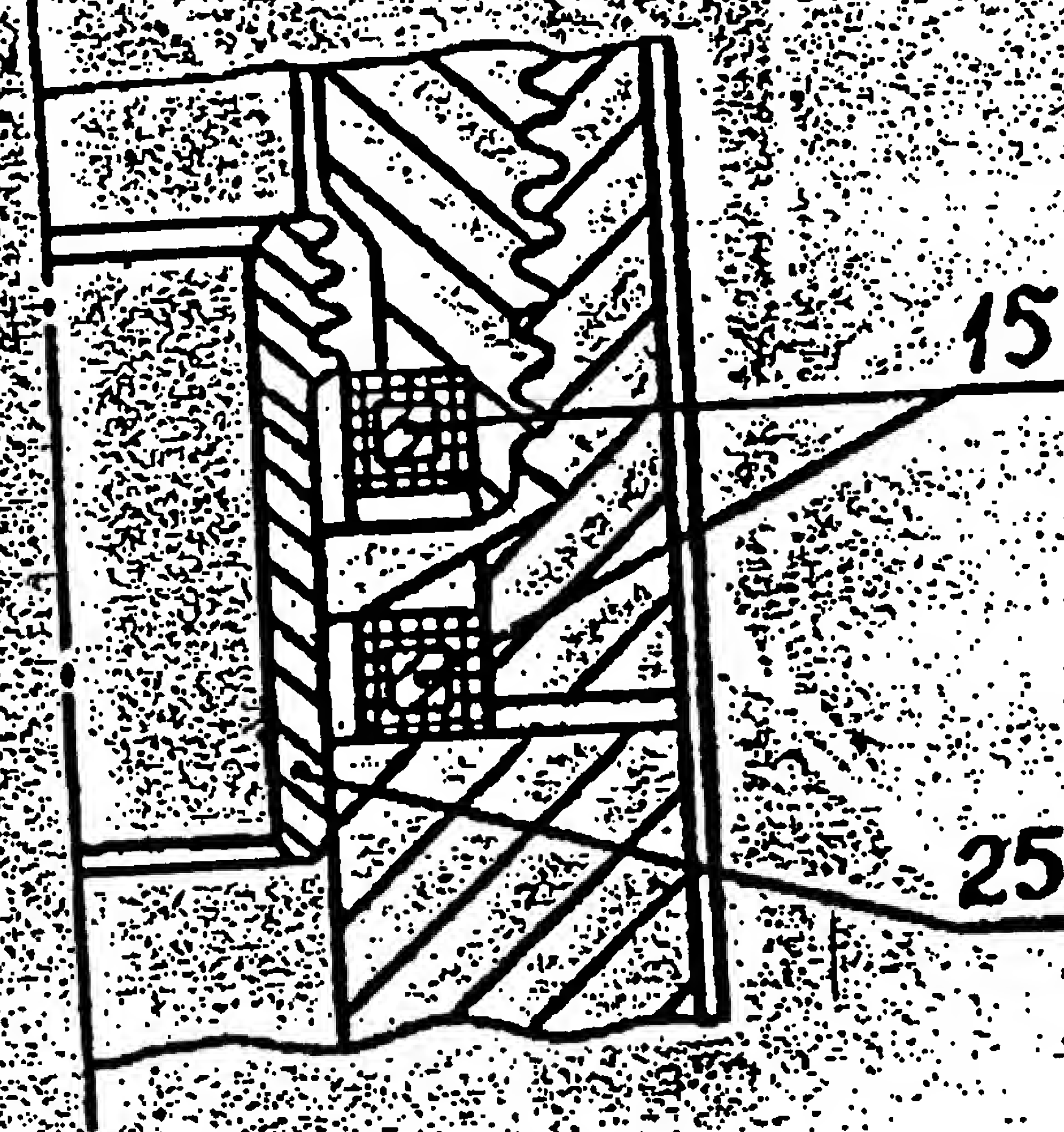


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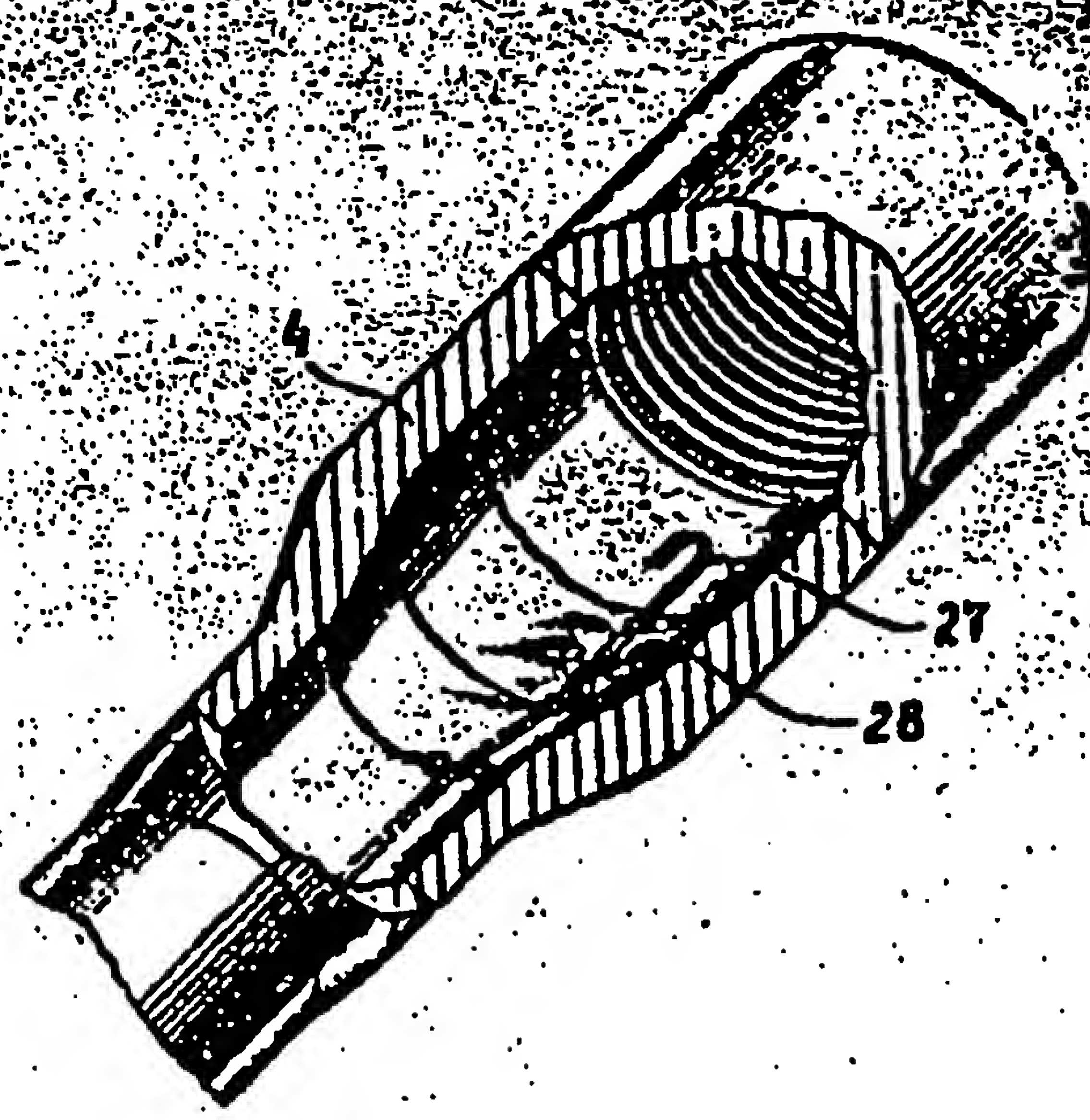
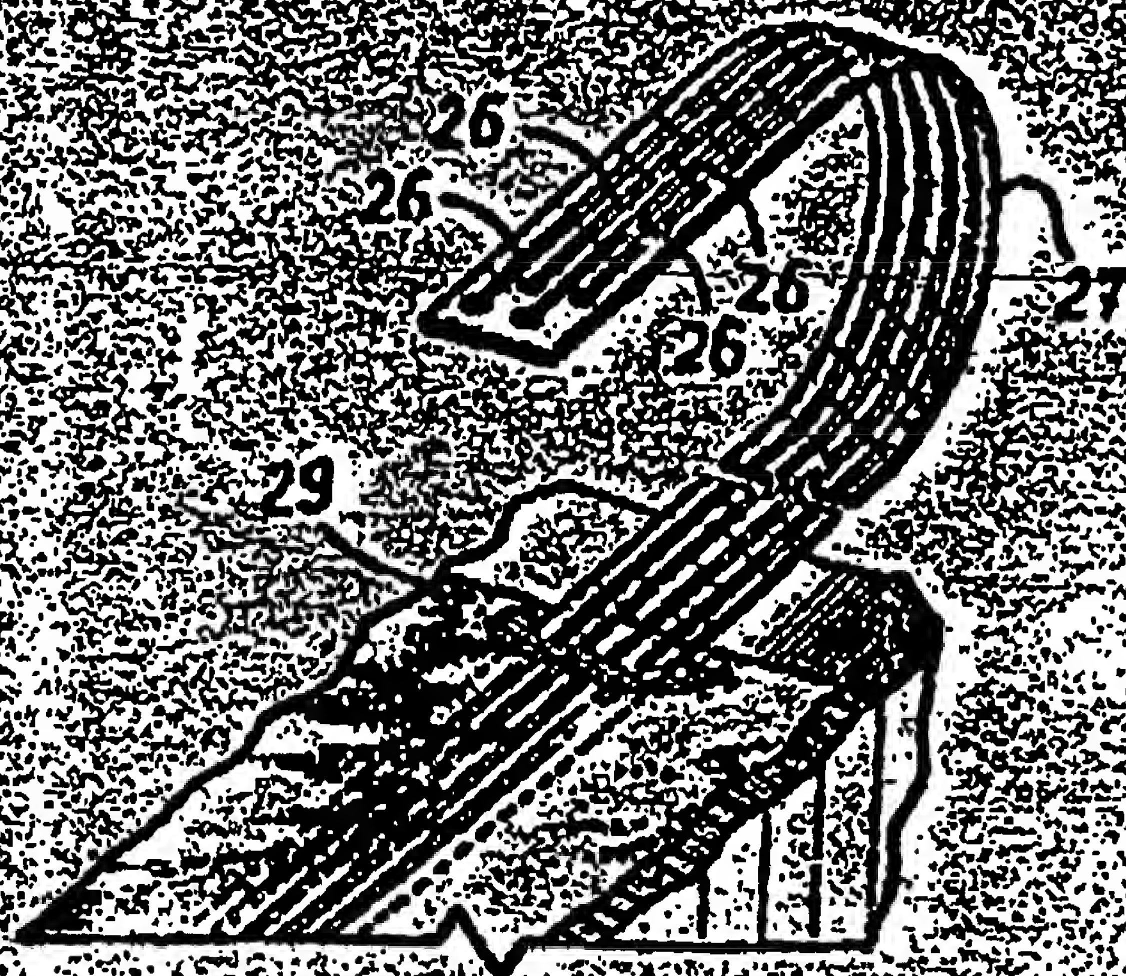



Фиг. 24




Фиг. 25

Редактор С.Кулакова Составитель С.Коновалов Техред М.Моргентал Корректор М.Куль

Заказ 606 Тираж Подписное

НПО "Поиск" Роспатента

113035, Москва, Ж-35, Раушская наб., 4/5

Производственно-издательский комбинат "Патент", г. Ужгород, ул.Гагарина, 101